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Laparoscopic sleeve gastrectomy (LSG) as a operative method of morbid obesity treatment and resolution of its comorbidities

Laparoskopowa rękawowa resekcja żołądka jako metoda operacyjnego leczenia otyłości patologicznej i chorób współistniejących

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Słowa kluczowe
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Conflict of interest
Konflikt interesów
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Summary

Introduction. Global pandemic of obesity, its quickly growing prevalence and life threatening comorbidities are one of the main healthcare issues of the 21st century. Research on metabolic disorders coexisting with obesity led to description of metabolic syndrome (MS). Urgent need to find effective methods of morbid obesity treatment provoked development of many bariatric surgery procedures, and among them, a relatively new procedure called LSG, that stands out to be safe and effective method in treating obesity and its comorbidities with their metabolic disorders.

Aim. Aim of the study was to analyze course of comorbidities and changes in BMI, blood pressure, glucose, lipids and other metabolism parameters in obese patients who undergone LSG procedure in 1-year follow-up.

Material and methods. The study is based on retrospective statistical analysis of own material acquired at 1-year prospective follow-up of 142 obese patients after LSG procedure, hospitalized and treated in our Clinic in years 2012 to 2015. The consent of the Bioethical Committee of Medical University of Bialystok, as well as written consent from all the subjected patients were obtained.

Results. Statistical analysis of data recorded at 1-year follow-up showed effective body weight loos, edification in glucose and lipid metabolism parameters and also total or partial remission on comorbidities, especially those forming metabolic syndrome, in majority of patients with morbid obesity subjected to LSG operation.

Conclusions. Laparoscopic sleeve gastrectomy (LSG) is safe, effective and comorbidity resolving procedure recommended as a primary surgical treatment method for patients with morbid obesity.

Streszczenie

Wstęp. Globalna epidemia otyłości, jej szybko rosnące występowanie i zagrażające życiu powikłania są jednym z głównych wyzwań opieki zdrowotnej w XXI wieku. Badania nad współistniejącymi z otyłością zaburzeniami metabolizmu doprowadziły do opisania zespołu metabolicznego. Pilna potrzeba poszukiwania skutecznych metod leczenia otyłości patologicznej spowodowała rozwój wielu technik w chirurgii bariatrycznej, a wśród nich – stosunkowo nowej procedury nazywanej LSG, która okazała się bezpieczną i skuteczną metodą w leczeniu otyłości wraz z towarzyszącymi jej zaburzeniami metabolizmu i chorobami współistniejącymi.

Cel pracy. Celem niniejszej pracy była analiza przebiegu chorób towarzyszących otyłości oraz zmian BMI, ciśnienia krwi, poziomu glukozy, lipidów i innych parametrów metabolicznych u chorych otyłych poddanych operacji LSG i pooperacyjnej obserwacji jednorocznej.

Materiał i metody. Opracowanie bazowało na retrospektywnej analizie danych zebranych na materiale własnym podczas prospektywnego, jednorocznego badania 142

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pacjentów otyłych, zoperowanych metodą LSG w naszej Klinice w latach 2012-2015. Uzyskano zgodę Komisji Bioetycznej Uniwersytetu Medycznego w Białymstoku oraz pisemne zgody pacjentów biorących udział w badaniu.

Wyniki. Analiza statystyczna danych zebranych w czasie jednorocznej obserwacji wykazała efektywną utratę masy ciała, poprawę parametrów metabolicznych glukozy i lipidów, a także częściowe lub nawet całkowite ustąpienie chorób współistniejących, w szczególności tych będących częścią zespołu metabolicznego, u większości pacjentów z otyłością patologiczną poddanych operacji LSG.

Wnioski. Laparoskopowa rękawowa resekcja żołądka (LSG) jest procedurą bezpieczną, skuteczną i leczącą także choroby współistniejące z otyłością, rekomendowaną jako pierwotne leczenie chirurgiczne pacjentów z otyłością patologiczną.

INTRODUCTION

Global pandemic of obesity is one of the main healthcare issues of the 21st century. It has a significant impression in socioeconomic and psychosocial areas of public health's interests. According to the newest WHO report from year 2011, number of people with BMI exceeding 30 has increased above 500 million, that makes up to 10% of worldwide population. Especially worth emphasizing is fact, that in last 30 years obesity occurrence increased almost twice among World's population (1). Quickly increasing number of obesity cases promotes development of many important comorbidities, such as: hypertension, non-insulin dependent diabetes (NIDDM), cardiovascular diseases, sleep apneas, osteoarticular system's diseases, depression and other (2, 3). In the last decades, much research work, aimed on reduction of mortality caused by cardiovascular diseases, that are main cause of death in general, has been taken to find associations between many metabolic disorders. In effect, the metabolic syndrome (MS) was described, named also as syndrome X, insulin resistance syndrome or deadly quartet, compromising abdominal obesity, hypertension, glucose intolerance and dyslipidemia. Conception of metabolic syndrome exists since about 80 years (4). However, only in the last decade a few trials to define it's uniform diagnostic criteria have been taken. The most well-known definition of the metabolic syndrome belonged to World Health Organization (WHO), stated in year 1998 (5), but nowadays it has become obsolete and has only historical importance. Actually, the most commonly used definition comes from American Heart Association (AHA) (6). According to variety of metabolic syndrome's diagnostic criteria, that result in many interpretational difficulties, there was a joint consensus published in year 2009. It states that necessary for MS diagnosis is coexistence of 3 among 5 previous criteria, without preferring obesity as a main criterion (7). In Poland, according to AHA-NHLBI definition, 23% men and 20% of women meet metabolic syndrome's diagnostic criteria (8-12). The results of epidemiological research prove, that the metabolic syndrome is also widespread in USA (13) and Europe (5, 12). Hitherto epidemiological researches asses, that among developed countries' population about 20-25% people meet the metabolic syndrome's diagnostic criteria (13, 14). Proved fact is also that patients with diagnosed MS undergo myocardial infarction or stroke 3 times more often and 5 times more often develop NIDDM than general population. According to proven relationship between metabolic syndrome and increased morbidity and mortality caused by cardiovascular diseases, in connection with obesity pandemic among World's population, reducing or stopping of wide spreading metabolic disorders is one of the most important challenges for contemporary medicine (15-17). Thus it seems obvious, that besides urgent need for effective prophylaxis of obesity, also appropriate treatment of already existing obesity cases is necessary. Interesting fact is that to certain moment, obesity was treated as a result, not as a cause of metabolic disorders. Nowadays, with contribution to bariatric surgery's development, comes possibility to observe how much normalization of patient's weight influences and even cures disorders in glucose and lipids metabolism. Thus it is reasonable to research among all bariatric procedures those, which not only permanently reduce body mass, but also normalize lipid levels the most and bring the best therapeutic effects in diabetes treatment (18). Among all surgical methods of morbid obesity treatment used in last 5 years, a relatively new procedure called laparoscopic sleeve gastrectomy (LSG) stands out very promising results in long- and short-term postoperative observation. These results are continuously published in actual scientific literature (19-21). LSG was first described by Iless and Marceau in 1988, as a part of duodenal switch (DS) with biliopancreatic diversion (BPD) operation (22). Further development led Johnston and affiliates to describe this method in 1993 as an isolated operation (23), and in year 1999, Gagner performed the first primary LSG. Laparoscopic sleeve gastrectomy operation technique compromises sub-total resection of stomach with creating a long, tubular gastric conduit based on minor curvature of the stomach. Weight loss and alignment in metabolic parameters within metabolic syndrome is caused not only by gastric resection itself, but also by following neurohormonal changes. LSG, as a procedure with relatively low postoperative complications risk, was at first indicated especially for super-obese patients (BMI > 60 kg/m^2), with high perioperative complication risk or as a procedure following laparoscopic Roux-en-Y gastric bypass (LGBP) operation. At present, it is also recommended as a isolated, definitive and effective bariatric operation (24), provid-

ing high therapeutic effectiveness in treatment of many metabolic syndrome's elements (20, 25).

According to fact, that LSG is one of the newest bariatric operations for morbid obesity treatment, there is few reports in scientific literature referring to its influence on obesity comorbidities. Our study aims to enrich knowledge base in this area.

AIM

The aim of this study was to analyze the influence of laparoscopic sleeve gastrectomy (LSG) procedure on diseases accompanying obesity – their partial remission, total resolution or worsening and also to collect, measure and statistically asses changes in biometric and biochemical metabolic parameters in patients with morbid obesity, who undergone this operation during 1-year follow-up.

MATERIAL AND METHODS

Our study bases on retrospective review of prospectively collected data derived form group of 142 patients with morbid obesity, qualified to bariatric surgery and operated using LSG procedure in the 1st Department of General and Endocrine Surgery of the University Hospital in Bialystok between years 2012 to 2015 (tab. 1). The consent of the Bioethical Committee of Medical University of Bialystok, as well as written consent from all the subjected patients were obtained. All operated patients were subsequently examined in 1-year follow-up. The patient follow up visits were scheduled at 1, 3, 6 and 12 months following the surgery at which the BMI and %EWL, %EBL (percentage of excess weight loos and excess BMI loos) was calculated and the resolution of comorbid illnesses was noted. %EWL and %EBL calculations was based on guidelines from year 2007, while resolution of comorbidities was based on cessation of medicine taken, symptoms' severity reduction and normalization of laboratory values. The patients have had diagnosed comorbidities, namely: depression, hypertension, non-insulin dependent diabetes (NIDDM), sleep apnea, chronic obstructive pulmonary disease (COPD), coronary disease, cholecystolithiasis, varicose veins of inferior limbs, hemorrhoids, deep vein thrombosis of inferior limbs, leg ulcerations, gastric and duodenal ulcers, gastritis, duodenitis, gastroesophageal reflux disease (GERD), oesophagitis, osteoarthritis of hip and knee joints, spinal pain, undergone myocardial infarction, that coexisted with obesity. Incidence percentages and numbers of these comorbidities in study group are presented in table 2.

During follow-up, also laboratory values of certain metabolism-related parameters, such as insulin, glucose, total cholesterol with LDL and HDL factions, triglycerides, urea, uric acid serum levels, were mea-

Tab. 1. Demographic data and mean preoperative biometric values of patients in study group with deviations

N = 142	Females = 78	Males = 64
Age (years)	45.82 ± 9.2	46.44 ± 12.2
Body weight (kg)	144.2 ± 21.14	151.3 ± 22.43
BMI (kg/m^2)	48.18 ± 6.5	51.08 ± 8.2

Tab. 2. Preoperative comorbidity types. Numbers and percentages among analyzed group of patients

Comorbidities	Before surgical treatment			
	F 78		M 64	
	n	%	n	%
Depression	36	25.35%	21	14.78%
Type 2 diabetes	28	19.71%	23	16.20%
Hypertension	34	23.94%	38	26.76%
Sleep apnea	15	10.56%	21	14.78%
Chronic obstructive pulmonary disease (COPD)	9	6.33%	17	11.97%
Coronary disease	9	6.33%	22	15.49%
Cholecystolithiasis	18	12.67%	7	4.92%
Varicose veins of inferior limbs	16	11.26%	13	9.15%
Hemorrhoids	5	3.52%	11	7.74%
Deep vein thrombosis of inferior limbs	3	2.11%	2	1.4%
Trophic leg ulcerations	6	4.22%	8	5.63%
Peptic ulcer disease of stomach and duodenum	11	7.74%	14	9.85%
Gastritis and duodenitis	26	18.30%	32	22.32%
Gastro-esophageal reflux disease (GERD)	8	5.63%	6	4.22%
Oesophagitis	12	8.45%	15	10.56%
Hip joint osteoarthritis	8	5.63%	4	2.81%
Knee joint osteoarthritis	4	2.81%	5	3.52%
Spinal pain	19	13.38%	26	18.30%
Undergone hearth infarct	0	0	5	3.52%

Tab. 3. Mean preoperative values and deviations of laboratory tested metabolic parameters

Fasting insulin (uU/L)	42.4 ± 21.62
Fasting glucose (mg/dl)	146.2 ± 52.30
Total cholesterol (mg/dl)	221.95 ± 19.40
Triglycerides (mg/dl)	176.4 ± 45.70
LDL-cholesterol (mg/dl)	152.40 ± 31.30
HDL-cholesterol (mg/dl)	44.20 ± 12.10
Uric acid (mg/dl)	5.81 ± 1.81
Urea (mg/dl)	35.34 ± 7.40
HOMA-IR	12.90 ± 10.60

sured, recorded and monitored for their variability over the observation time. Mean preoperative values and deviations of these lab tests are collected in table 3. Our study took into account also values and deviations of HOMA-IR (homeostatic model assessment insulin resistance index), calculated from the following formula:
HOMA-IR = {[fasting insulin [uU/ml] x fasting glucose [mmol/l]}/22.5.

Statistical analysis was done using the software Statistics 6.0 for Windows. The continuous variables were expressed as mean and standard deviation and compared using Students T-test. The p value < 0.05 was considered as statistically significant.

RESULTS

Our study group compromised 78 females (of average age 45.82 ± 9.2) and 64 males (of average age 46.44 ± 12.2). Mean preoperative body mass index (BMI) values and deviations were 48.18 ± 6.5 among females and 51.08 ± 8.2 in males. Recorded demographic and biometric data mentioned above, including also preoperative body weight and observed deviations of these parameters, are shown in table 1. Calculations of BMI among all analyzed cases during 1-year follow-up showed a gradual decrease in average initial values from mean 44.70 ± 6.7 ($p < 0.01$) after 1 month of observation to 30.6 ± 3.6 ($p < 0.00001$) at the end (12^{th} month), which is a 36.5% decrease (tab. 4, fig. 1).

Tab. 4. BMI mean values and deviations in study group at 1^{st}, 3^{rd}, 6^{th} and 12^{th} month of observation

	1st month	3rd month	6th month	1 year
BMI	44.70 ± 6.7 p < 0.01	41.7 ± 5.2 p < 0.0001	33.9 ± 3.8 p < 0.00001	30.6 ± 3.6 p < 0.00001

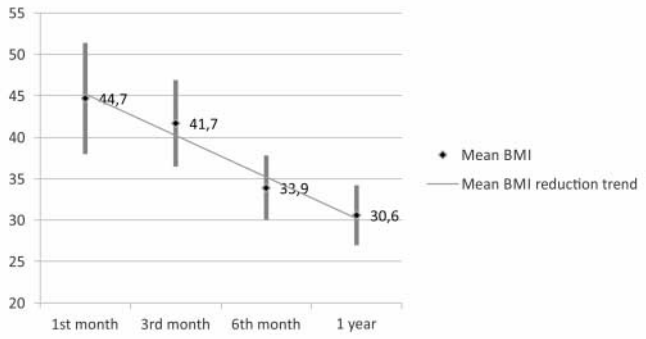

Fig. 1. Chart of BMI changes over the time of observation

%EWL and %EBL in study group were also measured and took under analysis. We noted significant increase of those parameters from 23.34 ± 3.65 ($p < 0.001$) for %EWL and 25.62 ± 5.8 ($p < 0.0001$) for %EBL, to 60.25 ± 8.35 ($p < 0.00001$) and 62.02 ± 6.90 ($p < 0.00001$) respectively in whole observation period, that means effective body weight loos in comparison to ideal body weight (IBW) among our patients after LSG operation (tab. 5, fig. 2). Another area of the postoperative follow-up was to mark and asses laboratory values of certain metabolic parameters in the study group. Postoperative glucose metabolism was evaluated on the basis of fasting glucose and insulin serum levels. Glycemia levels decreased from mean 107.2 ± 11.5 ($p < 0.05$) in 1st month of observation, to medium 89.76 ± 8.2 ($p < 0.05$) in 12^{th} month. Insulin values decreased respectively from 20.3 ± 14.4 ($p < 0.01$) to 12.5 ± 4.5 ($p < 0.05$). That suggests statistically significant drop in mean fasting glycemia by 16.3% and insulin by 38.4%. Derived from these laboratory tests mean HOMA-IR ratio decreased gradually by 1.18, that is 28.1% in relation to the initial values (tab. 6, fig. 3a,b). Lipid metabolism was assessed by analyzing laboratory values of total cholesterol (TC), HDL and LDL factions and triglycerides (TG) levels. Mentioned assessment revealed decrease in TC, LDL and TG values by medium 50 mg/dl (22.9%), 32.2 mg/dl (22.8%) and 36.2 mg/dl (28.1%) respectively, wherein HDL faction mean value rose by 13.9 mg/dl (26.5%) in our study group's follow-up (tab. 7, fig. 4). Observed changes in glucose and lipid metabolism laboratory parameters suggest positive influence of undergone LSG operation in that matter. One of the main aims of this study was evaluation of LSG's procedure impact on coexisting with obesity diseases in patients who undergone our follow-up. From all diagnosed comorbidity cases, majority partially recovered or was totally resolved. Especially worth emphasizing,

Tab. 5. %EWL and %EBL changes among analyzed patients after LSG procedure

	1st month	3rd month	6th month	1 year
%EWL	23.34 ± 3.65 p < 0.001	33.25 ± 4.6 p < 0.00001	49.1 ± 5.9 p < 0.0001	60.25 ± 8.35 p < 0.00001
%EBL	25.62 ± 5.8 p < 0.0001	37.74 ± 7.3 p < 0.00001	52.50 ± 7.8 p < 0.0001	62.02 ± 6.90 p < 0.00001

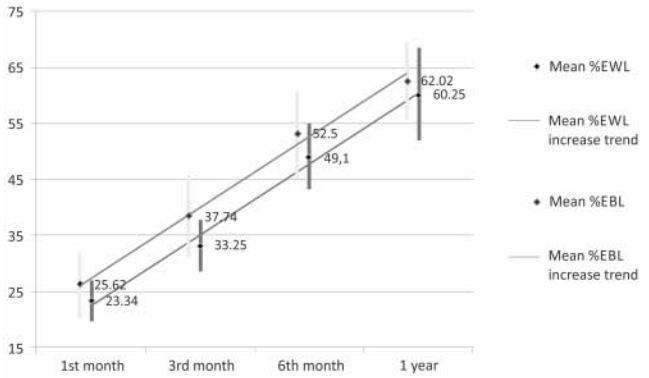

Fig. 2. Chart of %EWL and %EBL changes during follow-up

Tab. 6. Glucose and insulin fasting serum levels with calculated HOMA-IR at 1st, 3rd, 6th and 12th month of observation

	1st month	p	3rd month	p	6th month	p	1 year	p
Fasting insulin	20.3 ± 14.4	< 0.01	15.8 ± 1.3	< 0.01	14.7 ± 7.6	< 0.05	12.5 ± 4.5	< 0.05
Fasting glucose	107.2 ± 11.5	< 0.05	102.5 ± 9.4	< 0.01	96.6 ± 7.2	< 0.05	89.76 ± 8.2	< 0.05
HOMA-IR	4.2 ± 2.9	< 0.001	3.9 ± 2.8	< 0.01	3.4 ± 2.25	< 0.01	3.02 ± 1.66	< 0.05

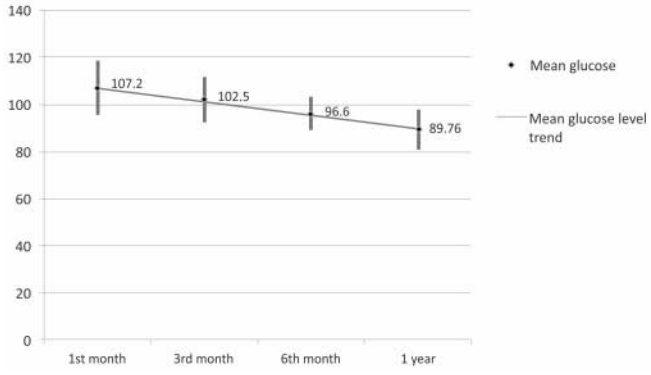

Fig. 3a. Chart of glucose serum levels variability after the LSG operation

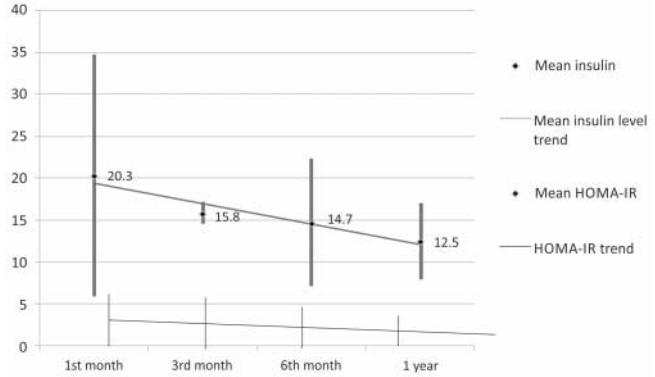

Fig. 3b. Chart of insulin fasting serum levels with calculated HOMA-IR variability after the LSG operation

Tab. 7. TC, HDL, LDL and TG lipid fractions serum levels at 1st, 3rd, 6th and 12th month of observation

	1st month	p	3rd month	p	6th month	p	1 year	p
Cholesterol	218.5 ± 28.5	NS	187.5 ± 12.4	< 0.0001	182.64 ± 8.7	< 0.0001	168.5 ± 7.6	
HDL	38.5 ± 8.6	< 0.001	38.7 ± 8.4	< 0.01	44.5 ± 7.9	< 0.0001	52.40 ± 6.8	< 0.001
LDL	141 ± 28.3	< 0.05	120 ± 23.5	< 0.05	116.7 ± 8.25	< 0.05	108.80 ± 8.4	
Triglycerides	128.7 ± 26.2	< 0.01	121.5 ± 19.5	< 0.01	114.65 ± 36.2	< 0.01	92.5 ± 23.12	< 0.01

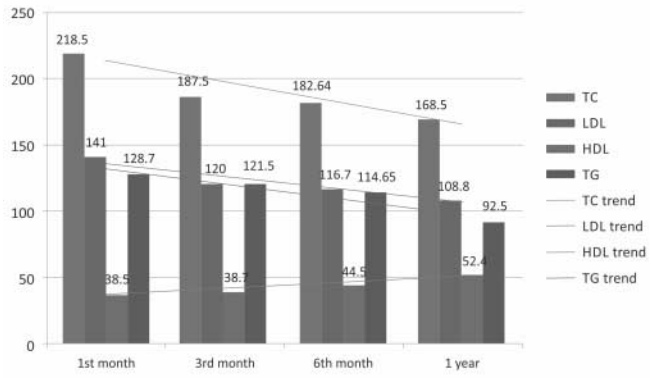

Fig. 4. Chart of TC. HDL. LDL and TG lipid fractions serum levels variability after the LSG operation

with contribution to previously described metabolic effect, was therapeutic influence of LSG procedure on NIDDM's partial or total remission, that was observed in all 51 recorded cases of this disease. Total remission cases, understood as symptoms' relief and medicines cessation, was observed in some patients with comorbidities such as: depression, hypertension, sleep apnea, chronic obstructive pulmonary disease (COPD), peptic ulcer disease, after 1 year of follow-up or earlier. Substantial remission was also frequently observed especially in patients with deep vein thrombosis, trophic leg ulcerations, gastritis, duodenitis, peptic ulcer disease, COPD, coronary disease, sleep apnea and spinal pain. Within those patients significant relief in the symptoms of the diseases was noted in number of cases ranging from 44-100%. Lower, but still significant remission percentages were observed among patients suffering from depression, hypertension, varicose veins of inferior limbs and hemorrhoids, where number of partially resolved cases ranged from 23.8 to 40%. All comorbidities and resolution rates with their numbers and percentages are recorded in table 8. At the follow-up we also observed some diseases, which were noted more often after undergoing LSG operation. Initially diagnosed number of GERD cases (8 males, 5.63% of study group and 6 females, 4.22%), after 1-year post-operative observation rose by 37.5% among men and by 50% in women. Increase in oesophagitis incidence from 12 (8.45% patients) to 15 cases among males, and from 15 (10.56% patients) to 19 cases among females also occurred at this follow-up (tab. 9). Cholecystolithiasis was noted in 25 (17.6%) patients from our study group. Seven (28%) of them underwent cholecystectomy before LSG procedure, and another 5 (20%) – after the operation. The patients with hip or knee osteoarthritis who underwent LSG procedure were afterwards prosthetized in 8 (66.6%) cases for hip joint and 4 (44.4%) cases for knee joint.

DISCUSSION

Nowadays, metabolic syndrome (MS), due to its significant prevalence and continuously growing number of cases, has very important epidemiological purport. Likewise its clinical impact cannot be missed, because cardiovascular disease's morbidity and mortality risk is undeniably higher in patients suffering from one

Tab. 8. Comorbidities, resolution rates, numbers and percentages observed at the follow-up

Comorbidity type	Before surgical treatment N = 142		Partial remission after 1 year N = 142		Total remission	
	F 78	M 64	F 78	M 64	F 78	M 64
Depression	36 25.35%	21 14.78%	12 33.33%	5 23.8%	3 8.33%	1 4.76%
Non-insulin dependent diabetes (NIDDM)	28 19.71%	23 16.20%	21 75%	19 82.6%	7 25%	4 17.40%
Hypertension	34 23.94%	38 26.76%	16 47.05%	12 31.57%	4 11.76%	
Sleep apnea	15 10.50%	21 14.78%	10 66.66%	11 52.38%	5 33.33%	6 28.57%
Chronic obstructive pulmonary disease (COPD)	9 6.33%	17 11.97%	5 55.55%	9 52.94%	2 22.22%	3 17.64%
Coronary disease	9 6.33%	22 15.49%	4 44.45%	13 59.09%		
Cholecystolithiasis	18 12.67%	7 4.92%				
Varicose veins of inferior limbs	16 11.26%	13 9.15%	4 25%	3 23.07%		
Hemorrhoids	5 3.52%	11 7.74%	2 40%	4 36.4%		
Deep vein thrombosis of inferior limbs	3 2.11%	2 1.4%	3 100%	2 100%		
Trophic leg ulcerations	6 4.22%	8 5.63%	6 100%	5 62.5%		
Peptic ulcer disease of stomach and duodenum	11 7.74%	14 9.85%	6 54.55%	8 57.14%		2 14.28%
Gastritis and duodenitis	26 18.30%	32 22.32%	18 69.23%	19 59.4%		
Gastro-esophageal reflux disease (GERD)	8 5.63%	4 2.81%				
Oesophagitis	4 2.81%	5 3.52%				
Hip joint osteoarthritis	19 13.38%	26 18.30%	17 89.47%	22 84.61%		
Knee joint osteoarthritis		5 3.52%				

Tab. 9. Numbers and percentages for comorbidities with increased prevalence after the LSG procedure

GERD	8 5.63%	6 4.22%	11 37.5%	9 50%
Oesophagitis	12 8.45%	15 10.56%	15 25%	19 26.66%

or more metabolic syndrome's components (25-27). One of the most important within those components is obesity, therefore comes a necessity for multidisciplinary approach aimed for researching and implementation of effective therapeutic methods. Such approach is shared and developed by many authors in scientific literature and clinical practice (27-29). Many effective therapeutic options developed owing to bariatric surgery. Despite this, there's still too few publications and large scale researches taking up the subject of the influence of existing operative methods on metabolic syndrome's remissive effects. One of those techniques is laparoscopic sleeve gastrectomy (LSG), which is proven to be very effective in postoperative body weight loss and, in comparison with other surgical methods, is one of the safest and provides fastest weight reduction at > 1 year long follow-ups (30-34). Thus it is recommended as a primary restrictive procedure even for super-obese patients and those with high perioperative risk caused by numerous comorbidities and is fraught with low complication risk (34, 35). Such patients were also treated with LSG procedure and prospectively followed up in our Clinic. Assessment of recorded data resulted in similar conclusions that those in mentioned above publications: we achieved effective body loss in our study group using LSG operation technique, described by mean BMI reduction from above 40 to below 30 and %EWL, %EBL percentages reaching 62%. Postoperative body weight reduction not only improves patient's comfort of the life, but is also connected with many metabolic syndrome's components resolution (35, 36). Particularly interesting is widely analyzed and described positive impact on

glucose metabolism and NIDDM remission in patients who undergone surgical treatment of morbid obesity. Numerous researches show significant edification in NIDDM course or its resolution, supported by glucose serum levels, insulin secretion and insulin resistance reduction after LSG operation (18, 19, 24, 25, 33-36). Our follow-up also proved gradual mean fasting serum glucose and insulin levels reduction after 12 months of observation with accompanying insulin resistance reduction, that was assessed by HOMA-IR calculations. Total remission of diabetes was observed in 21.6% cases from our study group. For more accurate NIDDM's remission evaluation, acquiring also postoperative HbA1C (glycated hemoglobin) values would be useful to better asses long-term glucose level fluctuations. Another important factor, that contributes atherosclerotic diseases morbidity and mortality risk, is lipid metabolism, especially total, HDL and LDL cholesterol factions and triglycerides levels. These parameters were also measured and recorded during our follow-up. Our results shown, that undergoing LSG operation influences in reduction of pro-atherosclerotic lipids level, namely TC, LDL and TG, meanwhile it increases HDL faction, that is considered a protective factor. Similar results can be found in scientific literature, so there comes a conclusion, that LSG procedure reduces cardiovascular diseases morbidity and mortality itself (35-39). Other area of this study compromised an observation of influence of LSG operation on coexisting with obesity diseases. We noted partial remission or total resolution of almost all diagnosed comorbidities. Such effects were also observed by other authors performing LSG procedure in patients suffering from morbid obesity and other coexisting illnesses (25, 35, 40-44). Especially worth emphasizing are casers of total comorbidity remission, understood as symptoms' relief and medicines cessation, observed in some patients with depression, hypertension, sleep apnea, chronic obstructive pulmonary disease (COPD), peptic ulcer disease, after 1 year of follow-up or earlier. Summarizing, laparoscopic sleeve gastrectomy appears to be safe, effective and comorbidity resolving procedure, but taking under consideration many coexisting factors, such as long-term outcome for the patient, qualification recommendations, patient's compliance with postoperative recommendations, obesity recurrence risk, anesthesia and operation technique related complication risk is still essential and demand individual and holistic approach in every case (14, 25, 41, 43, 44).

CONCLUSIONS

Laparoscopic sleeve gastrectomy (LSG) is effective and safe method for surgical treatment of morbid obesity, providing not only significant and fast body weight loss, but also resolving or reducing many comorbidities, especially those belonging to metabolic syndrome's components. Positive metabolic effect of LSG operation reduces cardiovascular morbidity and mortality risk, thus this method should be considered not only as a therapeutic, but also as a prophylaxis in issue of worldwide spreading metabolic disorders and reducing cardiovascular mortality rates.

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